IEP Proposal
Quality Assurance/Quality Control
Check List

Program Element Title: Benthos Bio Guide: A Guide to the Common and Important Benthic Invertebrates of the San Francisco Estuary

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I. Program Element Management
Program Element Description:

1. Background Information

Since 1975, the IEP Environmental Monitoring Program (EMP) has accumulated an extensive database of benthic community composition and abundance data collected at 22 stations in the upper San Francisco Estuary (upper SFE, includes San Pablo Bay, Suisun Bay, and the Delta see Attachment 1). To date, more than 3.3 million individual benthic organisms belonging to 283 species have been identified and enumerated. Comprehensive long-term data analyses (see proposal by Peterson et al.) are now possible and promise insights about major uncertainties such as the effects of species introductions, changes in food availability for fishes, etc. Furthermore, new interactive, web-based data analysis tools have been proposed to enable instantaneous data explorations by users with different information needs (EMP Review 2002). None of these analyses and subsequent interpretation of results can proceed in a meaningful and efficient way, however, without comprehensive, scientifically sound and easily accessible background information about the biology and ecology of the species present in this system. The "Benthos Bio Guide" proposed here will provide such information and serve as a prototype for similar efforts by other IEP program elements.

2. Purpose of Program Element in explicit terms.

Together with its two proposed sister program elements, this program element is intended to address the first of the three over arching questions identified by the IEP: "Are we monitoring the right things to reliably detect and quantify long-term ecosystem changes, and how well are we monitoring what we are monitoring?" The program element proposed here will provide essential information for the analyses of long-term changes in the benthic community (see proposal by Peterson et al) which in turn will provide information needed to evaluate the design of the EMP benthic element as noted in the EMP Review 2002. It will also serve as an important QA/QC tool for species identification.

Specifically, this program element is intended to provide answers to the following questions:

1) What is known about the natural history of benthos species monitored by the IEP EMP in the upper San Francisco Estuary, and;

2) How can this information best be made available?

For this program element we propose to compile comprehensive biological and ecological information for 41 of the most common and important species present in the upper SFE that are collected by the IEP EMP (see Attachment 2). These 41 species were selected based on the following criteria; 1) species representing the highest abundance overall of organisms collected by the EMP; 2) species commonly collected by the EMP program and potentially by other programs; 3) species of special concern or interest (eg. newly introduced species, or those species associated with actual and potential negative impacts to the SFE ecosystem).

Currently, there is no single source for basic background information about benthic macroinvertebrate species in the upper SFE. The Benthos Bio Guide produced by this program element will serve as a single, comprehensive resource for researchers and managers interested in identification and life-history information for common and important benthic species of the upper SFE (see Attachments 6 and 7 for sample Benthos Bio Guide pages). Online and hard copy versions of the Benthos Bio Guide will be made available to all interested parties.

Resources used to obtain background information will include primary literature, publications, personally communicating with experts and information available on the World Wide Web. Table 1 lists the primary literature we will use in compiling information about benthic invertebrates.

Table 1. Primary literature for the Benthos Bio Guide

Literature Titles
Brusca, R.C. and G.J. Brusca, 1990, Invertebrates. Sinauer Associates, Inc. Sunderland, Massachusetts, 922 pp.
Coffman, W. P. and L. C. Ferrington, Jr. 1996. Chironomidae, pp. 635-754 in: Merritt, R.W. and K.W. Cummins, Eds. An introduction to the Aquatic Insects of North America, 3rd ed., Kendall-Hunt, Dubuque, IA. 862 pp.
Cohen, A.N. and J.T. Carlton. 1995. Biological study: nonindigenous aquatic species in a United States estuary: a case study of the biological invasions of the San Francisco Bay and Delta. USFWS Rpt.
Kathman, R.D. and R.O. Brinkhurst. 1998. Guide to the Freshwater Oligochaetes of North America. Aquatic Resources Center, College Grove, TN. 264 pp.
Klemm, D. J. 1982. Leeches (Annelida: Hirudinea) of North America: EPA-600/3-82-025. EMSL, U.S.E.P.A., Cincinnati, OH 45268. 177 pp.
Pennak, R.W. 1978. Freshwater invertebrates of the United States, 2nd Ed. John Wiley & Sons, New York. 803 pp.
Smith, R.I. and J.T. Carlton. 1975. Light's Manual: Intertidal Invertebrates of the Central California Coast, 3rd Ed. UC Press, Berkley. 716 pp.
Thorp J. H. and A. P. Covich. 1991. Ecology and Classification of North American Freshwater Invertebrates. Academic Press Inc. San Diego, CA. 911 pp.

We will also search for relevant publications including journal articles, books, and technical reports. These resources are available at various University libraries (UC and CSU systems), through State and Federal agencies (eg. Department of Fish and Game (various states), US Fish and Wildlife Service, US Geological Survey), non-profit organizations (eg. San Francisco Estuary Institute) and professional societies (eg. North American Benthological Society, The Crustacean Society). Personal communication will include contacting local (EMP staff, Hydrozoology, California Academy of Sciences), national (Smithsonian Institution) and global (worldwide academic personnel for specific taxonomic groups) experts. Information on the World Wide Web is widely available for specific taxonomic groups (please see Relevant Web Sites below for examples we propose to use for this project). Web site information used may include non-copyrighted photographs or illustrations of specific species and/or some life-history information. Whenever possible, missing information such as photographs, biomass ranges (see proposal by Gehrts and Mueller-Solger), and distribution within the SFE will be augmented using historical and fresh benthos samples and data from the EMP benthos element.

To access the Benthos Bio Guide online, we propose to create several links on the current IEP Home Page (www.iep.water.ca.gov, see Attachment 3). The primary link will be created on the IEP Home Page and listed as a separate bulleted option called "Bio Guide" (www.iep.water.ca.gov/bioguide). We propose that the Benthos Bio Guide may be the first element of the "IEP Bio Guide" which we envision to eventually include Bio Guides for other organism groups monitored by the IEP (eg. zooplankton, phytoplankton). Secondary links will be created in the existing "EMP" Home Page (www.iep.water.ca.gov/emp) and in the "Data Vaults" Home Page (www.iep.water.ca.gov/data.html). Links on the IEP Home Page and the EMP Home Page will take the user directly to the "Bio Guide" Home Page. To access the Benthos Bio Guide from the "Data Vaults" Home Page users will need to query data from the "Benthos" database housed under the "B-DAT" link and then will be given the option to select a "library URL" taking them to the Benthos Bio Guide as part of the data output.

In addition to accessing the Benthos Bio Guide through the above mentioned pathways, users will also have access to a "Benthos Metadata File" (located on the EMP Home Page) link which describes in detail the history of the EMP benthic element, where the benthic sites are located, and sample methodology including number of replicates taken, sample collection, preservation and analysis. This effort to link all aspects of the IEP, the EMP and benthos monitoring in the upper SFE is part of our ongoing efforts to improve EMP “data to information” procedures and conduct more meaningful and comprehensive data analyses, and should also benefit other IEP programs.

To organize the collected information for the Benthos Bio Guide, a searchable, expandable, and editable Microsoft Access relational database will be constructed and stored in-house on the Environmental Water Quality and Estuarine Studies Branch server. This database will be relatively small and easy to store in-house allowing for quick access and minimal effort by EMP staff for editing and updating Bio Guide information. We propose the Benthos Bio Guide as a pilot study for an ongoing project to be conducted as part of the routine EMP monitoring procedures. For example, Species Summary Pages should be completed and updated as newly introduced species of concern (ie. zebra mussels) become established in the SFE or as new information becomes available. A copy of this database will be made available to all interested parties.

As templates for the structure, content, and search functions of the Benthos Bio Guide, we will primarily use the “FishBase” Global Information System on Fishes (see Attachment 4) and the Chesapeake Bay Life Guide (http://www.dnr.state.md.us/bay/cblife/benthos/index.html).

Other useful World Wide Web sources will be used and cited as needed. As in "FishBase," each benthos species in the Benthos Bio Guide will be described in a Species Summary Page following a consistent format and containing the following elements: Taxonomic information (following and linked to ITIS, the USDA Integrated Taxonomic Information System and cross-checked with Wayne Fields, Hydrozoology) reference collection code (see Gehrts and Mueller-Solger), morphology and identification information, including a drawing or photo, known occurrence in the SFE, and information on environmental requirements, life history and reproduction, physiology and behavior, functional (ie. feeding) group, and trophic relationships. Where known or applicable, the Species Summary Page will also list the status of species as native or exotic in the SFE (Cohen and Carlton 1995), if it is threatened or endangered, and if it poses a threat to humans or the system or is of other special concern to IEP and in the SFE. Finally, the Species Summary Page will give a main reference published for the species. Additional information will be provided on Secondary Pages accessible from links on the Species Summary Page and will contain more detailed information on all elements summarized on the Species Summary Page. Secondary Pages will contain more comprehensive reference lists, additional pictures, graphic displays of relevant EMP data, known global distribution, evolution, invasion history, and other interesting but less fundamental information gleaned from the literature, the World Wide Web, etc. Taxonomic or ecological terms used in the Species Summary Pages and the Secondary Pages will be linked to an online glossary to assist users not familiar with the terminology. In addition to individual Species Summary Pages and Secondary Pages, a Benthos Bio Guide Introduction page will be developed. The Introduction Page will be the initial web page viewed by users and will consist of a brief history and description of the Benthos Bio Guide with links to the IEP and EMP Home Pages, a list of all species included in the Benthos Bio Guide and a link to the online glossary. All pages in the Benthos Bio Guide will be editable (by EMP staff only), listing creation dates and updates as well as authors and editors to make all information presented traceable. In the future, the Benthos Bio Guide will be maintained, expanded, updated, and web links kept current as needed by EMP staff as part of the routine EMP information reporting procedures.

While the Benthos Bio Guide will provide species identification information, we do not intend to develop a new key for the benthic species found in the upper SFE. Comprehensive and accurate taxonomic keys that include the species selected for the Benthos Bio Guide already exist. To allow for easy access by Benthos Bio Guide users, a link on the Species Summary Page will provide a list of the best primary resources to use for species identification. The Species Summary Page will however, list several major and easily identifiable taxonomic characters for the individual species to assist researchers in identifying specimens. Development of a scientifically sound key for benthic species in the upper SFE is a challenging task and beyond the scope of this proposed program element.

In addition to the online version of the Benthos Bio Guide, a hard-copy version will be made available for distribution. Several templates will be used for structure and content of the hard-copy version. The two primary resources we will use are Rudy, J. and L. H. Rudy, "Oregon Estuarine Invertebrates: An Illustrated Guide to the Common and Important Invertebrate Animals", Oregon Institute of Marine Biology, University of Oregon (see Attachment 5), and Wang, J. 1986. Fishes of the Sacramento-San Joaquin Estuary and Adjacent Waters, California: A Guide To The Early Life Histories. IEP Technical Report 9. The hard-copy version will be in color and follow the format of the online version (including an Introduction, Species Summary and Secondary Pages). Additional funding for publication of the hard-copy version will not be requested from IEP because the Department of Water Resources' Reprographics Department can provide printing services using General Funds.

3. How will data and information from the program element be used?

Information compiled in the Benthos Bio Guide may be used by State and Federal agency personnel, academic researchers, and by the public. This information will be essential for improved analysis and interpretation of benthos monitoring data as recommended by the EMP reviewers (EMP Review 2002). It may be used for a variety of research interests including fish diet studies in the upper SFE, basic biology and ecology of indicator species (for water quality conditions), basic information about introduced species (especially those considered detrimental to the ecosystem of the SFE), and as background information for trophic ecology studies. Information in the Benthos Bio Guide may be used for public outreach and education purposes especially for introduced species that are currently having or may have the potential to negatively impact the SFE or the water projects.

4. How may this data and information be used by other current studies or future work?

The Benthos Bio Guide may be updated as needed to include newly introduced species into the SFE that have been responsible for negative impacts in other systems (eg. zebra mussels and the New Zealand mud snail). The online version of the Benthos Bio Guide may serve as a centralized and familiar source of information that can be quickly and easily utilized by personnel needing biological and ecological information on such species. The Benthos Bio Guide may serve as a template for Bio Guides for other organisms monitored by the IEP. Information utilized from the Benthos Bio Guide will serve to further integrate the various monitoring elements of the EMP (eg. water quality, zooplankton, etc.). An example of this integration may be the ability to link life-history information with changes in trends of benthos collected under certain water quality conditions.

5. What are the biological implications of the program element?

There are no biological implications associated with this program element.

6. Has this proposal been submitted elsewhere for funding or do you plan to submit it elsewhere for funding?

This proposal has not been submitted elsewhere for funding. There are currently no plans to submit this proposal elsewhere for funding.

Due Dates and Products

1. What is the program element timeline and what is the completion date?

This is a two- year project (January 2004 - December 2005). The online version of the Benthos Bio Guide will be a continuous process with individual Species Summary Pages and Secondary Pages uploaded onto the IEP Home Page as they are completed. At the end of the two- year period (December 2005), the completed online and printed hard-copy versions of the Benthos Bio Guide, containing 41 benthos species, will be available.

2. What products or deliverables will the program element produce and what are the due dates for them? Include both dates for drafts and final products.

The main products for this program element will be an online version and a hard-copy version of the Guide to the Common and Important Benthic Invertebrates of the San Francisco Estuary (Benthos Bio Guide), including a completed Introduction Page (see Attachment 6), Species Summary Pages (see Attachment 7) and Secondary Pages for the 41 benthos species listed in Attachment 2. This information will immediately benefit the sister project proposed by Peterson et al. We propose to place a Bio Guide web link on the IEP Home Page alongside the existing IEP Data Vaults and will also be accessible through the EMP Home Page and the Data Vaults Home Page. Principal investigators for this project will give regular presentations about project progress during IEP Benthic Estuarine Ecology Team (BEET, a subgroup of the IEP EET) meetings and submit an IEP newsletter article about project scope, the nature and building of the Benthos Bio Guide, and interesting findings. Principal investigators will request review of the Benthos Bio Guide (online version) by appropriate experts as specific taxonomic groups are completed. Review of the draft hard-copy version of the Benthos Bio Guide will be requested in September of 2005. Another important "product" of this program element is increased benthos expertise among EMP staff and better documentation to help the program become less dependent on outside experts. The Benthos Bio Guide will thus help improve and assure the quality and long-term consistency of EMP benthos data and analyses, and facilitate integration of benthos data in more comprehensive ecological assessments by providing easily accessed, detailed information, visual images, etc. to experts from all disciplines. The Benthos Bio Guide will also establish a means of quality control for the EMP program by assuring EMP staff is using the most current taxonomic classification and information for the selected species. Finally, the Benthos Bio Guide will serve as a useful public outreach and education tool for IEP.

Table 2. Products, Deliverables and Due Dates

Products or Deliverables	Draft Due Dates	Final Due Dates
Benthos Bio Guide (web based version)	March 2004 - December 2005	December 2005
Benthos Bio Guide (paper version)	September 2005	December 2005
IEP Home Page Links	N/A	March 2004
Database for Bio Guide information	N/A	March 2004 - December 2005
IEP BEET presentations	N/A	Starting March 2004, ongoing as needed
IEP Newsletter article	Summer 2004	Fall 2004

Project Resource Needs:

Resources

Please see Tables 3.1 through 3.4 for details of several proposed budget plans. In anticipation of the State "hiring freeze" for the Department of Water Resources lasting until at least July 2004, we are including several budget scenarios with varying percentages of time for C. Messer and for a Scientific/Student Aid. In all scenarios, the varying time allotment for staff will ensure this project can be completed in time and within the estimated budget. We will explore other options for obtaining temporary help if necessary to help fill the Scientific Aid position for this program (eg. Student Aid via the Science Consortium). In the proposed budget scenarios we have included time and requested funding for either a DWR Scientific Aid or a Student Aid hired through the Science Consortium using DWR rates.

For this program, we are requesting IEP funding for salary for Cindy Messer and for a Scientific/Student Aid only. Currently, Cindy Messer, a DWR Environmental Scientist Range C, only receives 10% of her salary from IEP EMP funds. The remainder of her salary currently comes from two CALFED projects one ending in Spring 2003, the second ending in Spring 2004. Anke Mueller-Solger is a DWR staff scientist receiving 80% of her salary from the IEP EMP budget. Her work on this proposed program element here will be covered by the EMP under the current arrangements. Marc Vayssieres' time will be covered under the DWR CALFED Science Program. These "matching funds" for A. Mueller-Solger and M. Vayssieres amount to a cost-savings of $37,400 for the proposed program element.

Program Element Budget

Plan A describes the budget under optimal circumstances (availability of a DWR Scientific Aid, 75% time for 7/04-12/05, time for C. Messer is 50% for 1/04-6/04 and 30% for 7/04-12/05).

Total funding requested for 2004-2005 under Plan A is: **$ 144,768.00** (w/DWR Scientific Aid)

Table 3.1 Plan A - Optimal Budget Scenario

Task	Personnel	Dates	Activity Rate[1]	Percent Time	Hours[2]	2004 Costs	2005 Costs	Staff Costs	Project Costs
Consultation and Project supervision	Anke Mueller-Solger (DWR)[3] (Staff Environmental Scientist)	1/04 to 6/04	N/A	5.0%	47	$0			
		7/04 to 12/04	N/A	5.0%	47	$0			
		1/05 to 6/05	N/A	5.0%	47		$0		
		7/05 to 12/05	N/A	5.0%	47		$0	**$0**	
Consultation, web page and database design	Marc Vayssieres (DWR)[4] (Staff Environmental Scientist)	1/04 to 6/04	N/A	10.0%	94	$0			
		7/04 to 12/04	N/A	10.0%	93	$0			
		1/05 to 6/05	N/A	10.0%	94		$0		
		7/05 to 12/05	N/A	10.0%	93		$0	**$0**	
Consultation and Benthos Bio Guide development	Cindy Messer (DWR) (Environmental Scientists C)	1/04 to 6/04	$62.02	50.0%	468	$29,025			
		7/04 to 12/04	$68.22	30.0%	281	$19,170			
		1/05 to 6/05	$68.22	30.0%	281		$19,170		
		7/05 to 12/05	$75.04	30.0%	281		$21,086		
						$48,195	$40,256	**$88,451**	
Benthos Bio Guide development	TBD (DWR) (Scientific Aid)	1/04 to 6/04	$22.57	0.0%	0	$0			
		7/04 to 12/04	$24.83	75.0%	732	$18,176			
		1/05 to 6/05	$24.83	75.0%	731		$18,151		
		7/05 to 12/05	$27.31	75.0%	732		$19,991		
						$18,176	$38,142	**$56,317**	
Project Total (w/DWR Sci Aid)						**$66,370**	**$78,398**		**$144,768**

[1]Labor costs based on DWR Activity rates, which include salary, benefits and overhead charges.
[2]Cost figures above based on total number of estimated labor hours for each staff person (not including vacation/holiday hours). Hours allotted for each staff person per calendar year are: Anke M-S (1872), Marc V. (1872), Cindy M. (1872), Scientific Aid (1950).
[3]EMP matching: 1 Staff Environmental Scientist (Anke Mueller-Solger, Project supervisor & ecologist), 2 yrs. @ 5% time ($ 9,400.00 – will be covered by EMP, not requested here!)
[4]CALFED matching: 1 Staff Environmental Scientist (Marc V, Database expert & ecologist), 2 yrs. @ 10% time ($ 28,000 – will be covered by DWR CalFed Science program, not requested here!)
[5]If possible, the Scientific Aid will be hired through DWR. If the State hiring freeze is still in effect, we will seek assistance from the Science Consortium Program for hiring a Student Assistant. Estimates for "Activity Rate" for the Student Assistant are double those of the DWR Scientific Aid to allow for possible overhead required by U.C. Davis.

Plan B describes the budget under the most likely circumstances (availability of a DWR Scientific Aid, 50% time for 7/04-12/04 (sharing a full-time aid w/another project) and 75% time for 2005, time for C. Messer is 50% for all 2004, 30% for all 2005)

Total funding requested for 2004-2005 under Plan B is: **$ 151,442.00** (w/DWR Scientific Aid)

Table 3.2 Plan B - Most Likely Budget Scenario

Task	Personnel	Dates	Activity Rate[1]	Percent Time	Hours[2]	2004 Costs	2005 Costs	Staff Costs	Project Costs
Consultation and Project supervision	Anke Mueller-Solger (DWR)[3] (Staff Environmental Scientist)	1/04 to 6/04	N/A	5.0%	47	$0			
		7/04 to 12/04	N/A	5.0%	47	$0			
		1/05 to 6/05	N/A	5.0%	47		$0		
		7/05 to 12/05	N/A	5.0%	47		$0	**$0**	
Consultation, web page and database design	Marc Vayssieres (DWR)[4] (Staff Environmental Scientist)	1/04 to 6/04	N/A	10.0%	94	$0			
		7/04 to 12/04	N/A	10.0%	93	$0			
		1/05 to 6/05	N/A	10.0%	94		$0		
		7/05 to 12/05	N/A	10.0%	93		$0	**$0**	
Consultation and Benthos Bio Guide development	Cindy Messer (DWR) (Environmental Scientist C)	1/04 to 6/04	$62.02	50.0%	468	$29,025			
		7/04 to 12/04	$68.22	50.0%	468	$31,927			
		1/05 to 6/05	$68.22	30.0%	281		$19,170		
		7/05 to 12/05	$75.04	30.0%	281		$21,086		
						$60,952	$40,256	**$101,208**	
Benthos Bio Guide development	TBD (DWR) (Scientific Aid)	1/04 to 6/04	$22.57	0.0%	0	$0			
		7/04 to 12/04	$24.83	50.0%	487	$12,092			
		1/05 to 6/05	$24.83	75.0%	731		$18,151		
		7/05 to 12/05	$27.31	75.0%	732		$19,991		
						$12,092	$38,142	**$50,234**	
Project Total (w/DWR Sci Aid)						**$73,045**	**$78,398**		**$151,442**

[1]Labor costs based on DWR Activity rates, which include salary, benefits and overhead charges.
[2]Cost figures above based on total number of estimated labor hours for each staff person (not including vacation/holiday hours). Hours allotted for each staff person per calendar year are: Anke M-S (1872), Marc V. (1872), Cindy M. (1872), Scientific Aid (1950).
[3]EMP matching: 1 Staff Environmental Scientist (Anke Mueller-Solger, Project supervisor & ecologist), 2 yrs. @ 5% time ($ 9,400.00 – will be covered by EMP, not requested here!)
[4]CALFED matching: 1 Staff Environmental Scientist (Marc V, Database expert & ecologist), 2 yrs. @ 10% time ($ 28,000 – will be covered by DWR CalFed Science program, not requested here!)
[5]If possible, the Scientific Aid will be hired through DWR. If the State hiring freeze is still in effect, we will seek assistance from the Science Consortium Program for hiring a Student Assistant. Estimates for "Activity Rate" for the Student Assistant are double those of the DWR Scientific Aid to allow for possible overhead required by U.C. Davis.

Plan C describes the budget under a scenario where the State hiring freeze stays in effect through 2004 (DWR Scientific Aid, 0% time for 2004 and 75% time for 2005, time for C. Messer is 50% for all 2004 and 50% for all 2005).

Total funding requested for 2004-2005 under Plan C is: **$ 166,140.00** (w/DWR Scientific Aid)

Table 3.3 Plan C - Budget Scenario

Task	Personnel	Dates	Activity Rate[1]	Percent Time	Hours[2]	2004 Costs	2005 Costs	Staff Costs	Project Costs
Consultation and Project supervision	Anke Mueller-Solger (DWR)[3] (Staff Environmental Scientist)	1/04 to 6/04	N/A	5.0%	47	$0			
		7/04 to 12/04	N/A	5.0%	47	$0			
		1/05 to 6/05	N/A	5.0%	47		$0		
		7/05 to 12/05	N/A	5.0%	47		$0	**$0**	
Consultation, web page and database design	Marc Vayssieres (DWR)[4] (Staff Environmental Scientist)	1/04 to 6/04	N/A	10.0%	94	$0			
		7/04 to 12/04	N/A	10.0%	93	$0			
		1/05 to 6/05	N/A	10.0%	94		$0		
		7/05 to 12/05	N/A	10.0%	93		$0	**$0**	
Consultation and Benthos Bio Guide development	Cindy Messer (DWR) (Environmental Scientists C)	1/04 to 6/04	$62.02	50.0%	468	$29,025			
		7/04 to 12/04	$68.22	50.0%	468	$31,927			
		1/05 to 6/05	$68.22	50.0%	468		$31,927		
		7/05 to 12/05	$75.04	50.0%	468		$35,119		
						$60,952	$67,046	**$127,998**	
Benthos Bio Guide development	TBD (DWR) (Scientific Aid)	1/04 to 6/04	$22.57	0.0%	0	$0			
		7/04 to 12/04	$24.83	0.0%	0	$0			
		1/05 to 6/05	$24.83	75.0%	731		$18,151		
		7/05 to 12/05	$27.31	75.0%	732		$19,991		
						$0	$38,142	**$38,142**	
Project Total (w/DWR Sci Aid)						**$60,952**	**$105,187**		**$166,140**

[1]Labor costs based on DWR Activity rates, which include salary, benefits and overhead charges.
[2]Cost figures above based on total number of estimated labor hours for each staff person (not including vacation/holiday hours).
Hours allotted for each staff person per calendar year are: Anke M-S (1872), Marc V. (1872), Cindy M. (1872), Scientific Aid (1950).
[3]EMP matching: 1 Staff Environmental Scientist (Anke Mueller-Solger, Project supervisor & ecologist), 2 yrs. @ 5% time ($ 9,400.00 – will be covered by EMP, not requested here!)
[4]CALFED matching: 1 Staff Environmental Scientist (Marc V, Database expert & ecologist), 2 yrs. @ 10% time ($ 28,000 – will be covered by DWR CalFed Science program, not requested here!)
[5]If possible, the Scientific Aid will be hired through DWR. If the State hiring freeze is still in effect, we will seek assistance from the Science Consortium Program for hiring a Student Assistant. Estimates for "Activity Rate" for the Student Assistant are double those of the DWR Scientific Aid to allow for possible overhead required by U.C. Davis.

Plan D describes the program element budget using a Student Aid via the Science Consortium for the duration of the project (assumption is that the State hiring freeze stays in effect through 2005, Student Aid time 75% for all 2004 and 2005, time for C. Messer is 30% for all 2004 and 2005)

Total funding requested for 2004-2005 under Plan D is: **$ 222,486.00** (w/Student Aid)

Table 3.4 Plan D - Budget Scenario

Task	Personnel	Dates	Activity Rate[1]	Percent Time	Hours[2]	2004 Costs	2005 Costs	Staff Costs	Project Costs
Consultation and Project supervision	Anke Mueller-Solger (DWR)[3] (Staff Environmental Scientist)	1/04 to 6/04	N/A	5.0%	47	$0			
		7/04 to 12/04	N/A	5.0%	47	$0			
		1/05 to 6/05	N/A	5.0%	47		$0		
		7/05 to 12/05	N/A	5.0%	47		$0	**$0**	
Consultation, web page and database design	Marc Vayssieres (DWR)[4] (Staff Environmental Scientist)	1/04 to 6/04	N/A	10.0%	94	$0			
		7/04 to 12/04	N/A	10.0%	93	$0			
		1/05 to 6/05	N/A	10.0%	94		$0		
		7/05 to 12/05	N/A	10.0%	93		$0	**$0**	
Consultation and Benthos Bio Guide development	Cindy Messer (DWR) (Environmental Scientists C)	1/04 to 6/04	$62.02	30.0%	281	$17,428			
		7/04 to 12/04	$68.22	30.0%	281	$19,170			
		1/05 to 6/05	$68.22	30.0%	281		$19,170		
		7/05 to 12/05	$75.04	30.0%	281		$21,086		
						$36,598	$40,256	**$76,854**	
Benthos Bio Guide development	**TBD (Science Consortium)[5] (Student Aid)**	1/04 to 6/04	$45.14	75.0%	731	$32,997			
		7/04 to 12/04	$49.66	75.0%	732	$36,351			
		1/05 to 6/05	$49.66	75.0%	731		$36,301		
		7/05 to 12/05	$54.62	75.0%	732		$39,982		
						$69,348	$76,283	**$145,632**	
Project Total (w/Science Consortium Student Aid)						**$105,946**	**$116,539**		**$222,486**

[1]Labor costs based on DWR Activity rates, which include salary, benefits and overhead charges.
[2]Cost figures above based on total number of estimated labor hours for each staff person (not including vacation/holiday hours).
Hours allotted for each staff person per calendar year are: Anke M-S (1872), Marc V. (1872), Cindy M. (1872), Scientific Aid (1950).
[3]EMP matching: 1 Staff Environmental Scientist (Anke Mueller-Solger, Project supervisor & ecologist), 2 yrs. @ 5% time ($ 9,400.00 – will be covered by EMP, not requested here!)
[4]CALFED matching: 1 Staff Environmental Scientist (Marc V, Database expert & ecologist), 2 yrs. @ 10% time ($ 28,000 – will be covered by DWR CalFed Science program, not requested here!)
[5]If possible, the Scientific Aid will be hired through DWR. If the State hiring freeze is still in effect, we will seek assistance from the Science Consortium Program for hiring a Student Assistant. Estimates for "Activity Rate" for the Student Assistant are double those of the DWR Scientific Aid to allow for possible overhead required by U.C. Davis.

1. Personnel Needs

   1 Staff Environmental Scientist (Anke Mueller-Solger, Ph.D., Aquatic ecologist)
   1 Staff Environmental Scientist (Marc Vayssieres, Ph.D., Database expert & ecologist)
   1 Environmental Scientist, Range C (Cindy Messer, M.S. candidate, Benthos ecologist)
   1 Fish and Wildlife Scientific Aid

2. Equipment Needs

   No major equipment purchases are anticipated. The EMP will provide computing, sampling, and sample processing resources as needed.

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Carlton, J.T., J.K. Thompson, L.E. Schemel and F.H. Nichols 1990. Remarkable invasion of San Francisco bay by the Asian Clam *Potamocorbula amurensis*. 1. Introduction and dispersal. Mar. Ecol. Prog. Ser. 66: 81-94.

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Voshell, J. R. 2002. A Guide to Common Freshwater Invertebrates of North America. The McDonald and Woodward Publishing Company, Blacksburg, Virginia. 442 pp.

Relevant Web Sites:

IEP benthos data base: http://sarabande.water.ca.gov:8000/~bdtdb/dwr1.html

IEP online technical reports. Wang, J. 1986. Fishes of the Sacramento-San Joaquin Estuary and Adjacent Waters, California: A Guide To The Early Life Histories. Technical Report 9: http://elib.cs.berkeley.edu/kopec/tr9/html/home.html

"FishBase" Global Information System on Fishes: http://www.fishbase.org/home.htm.

"ITIS" - USDA Integrated Taxonomic Information System: http://www.itis.usda.gov/

ITIS Taxonomic Resources and Expertise Directory:
http://www.nbii.gov/datainfo/syscollect/tred/index.html)

Maryland DNR Chesapeake Bay Life Guide: http://www.dnr.state.md.us/bay/cblife/benthos/index.html

"Catalogue of Life" project: http://www.sp2000.org/pressrel130601.html

"BiologyBase:" http://www.biologybase.com/

"MarLIN" – Marine Life Information Network (UK): http://www.marlin.ac.uk/marlin_home_new.htm

Additional BBG Project Information:

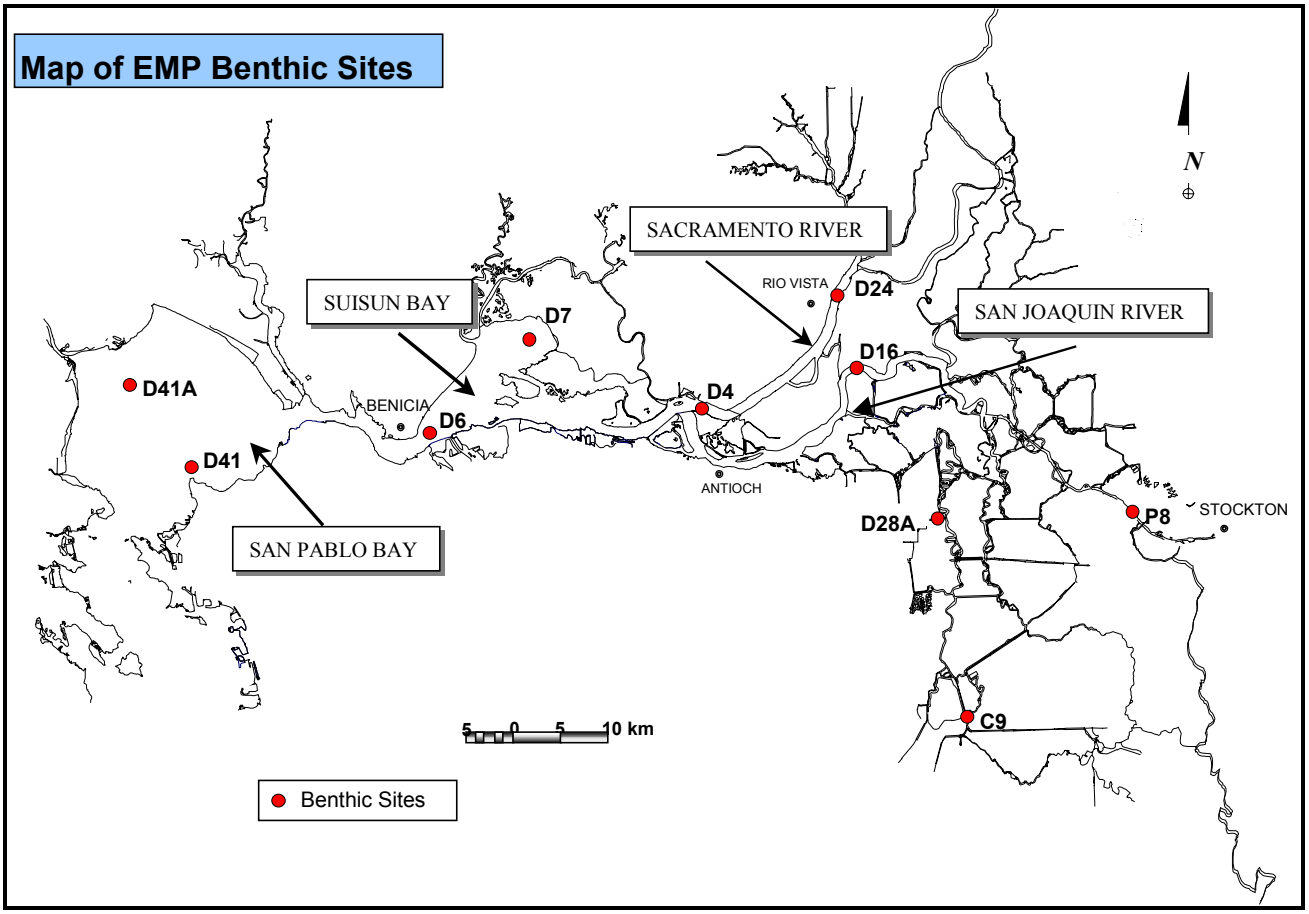
Regional collaborators and contributors:

- Wayne Fields of Hydrozoology;
- Jan Thompson, Heather Peterson and colleagues at the USGS, Menlo Park;
- Bruce Thompson and colleagues at SFEI;
- The IEP Benthos Estuarine Ecology Team "BEET." Formation of the BEET was recommended in the 2001-2002 review of the IEP EMP. The first official BEET meeting organized by Jan Thompson will take place in Oct. 2002. A BEET planning meeting took place on Sep. 4, 2002, at SFSU-RTC, and resulted in the conceptual design of the three sister benthos concept proposal to be submitted to IEP for 2004 funding. All of these proposals are based on recommendations included in the EMP review.

Project Oversight and Expert Advice:

At all stages of the project, the BBG team will closely consult with the IEP BEET, collaborating regional benthos ecologists, and expert taxonomists (regional, and listed in the ITIS **"**Taxonomic Resources and Expertise Directory"). Junior staff will be trained and supervised by senior staff. Potential interactions with the FishBase team, the new global 'Catalogue of Life' Project, the California Academy of Sciences' SF Bay 2K Project, etc. will be explored.

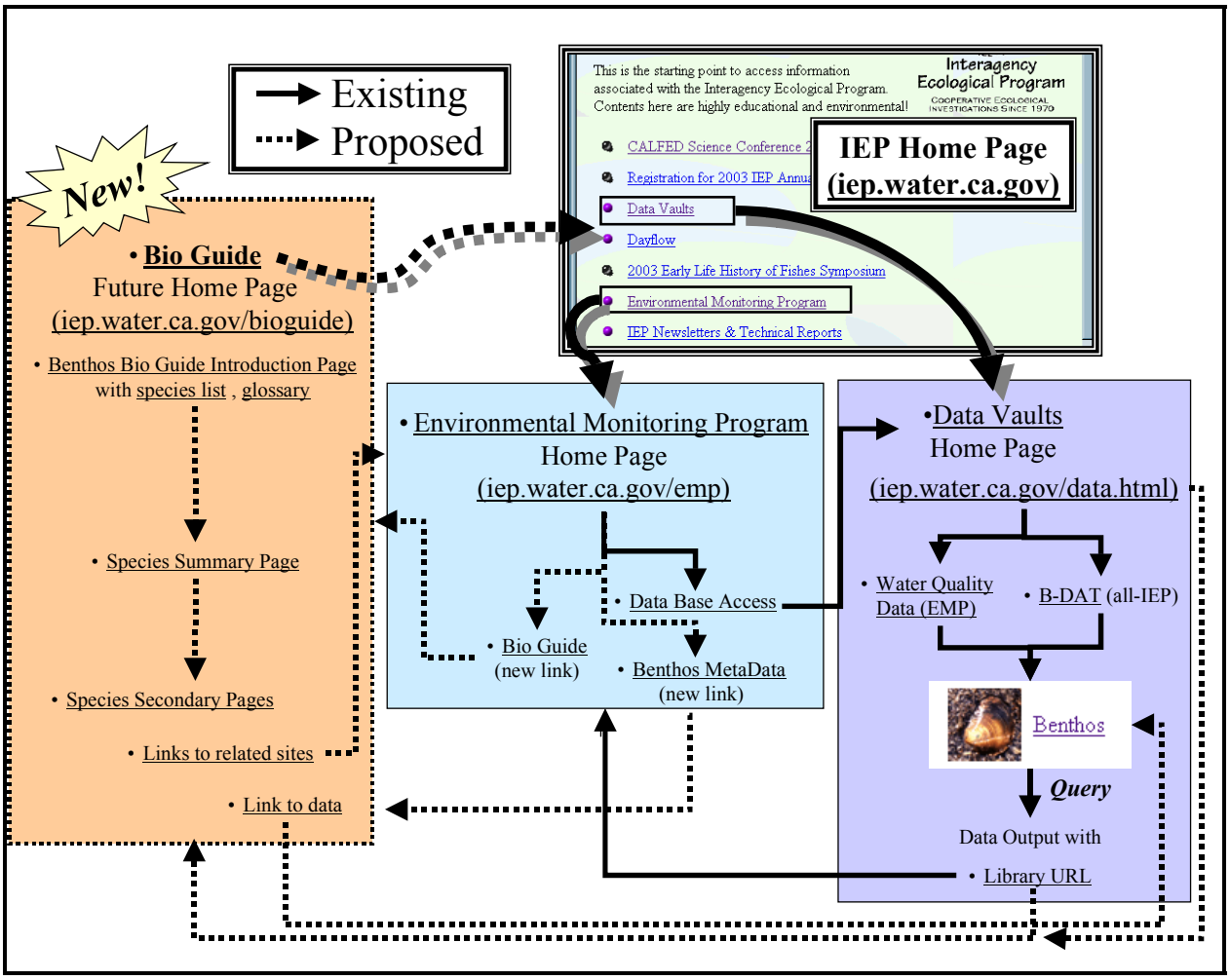
Attachment 1. IEP EMP Benthic Sites



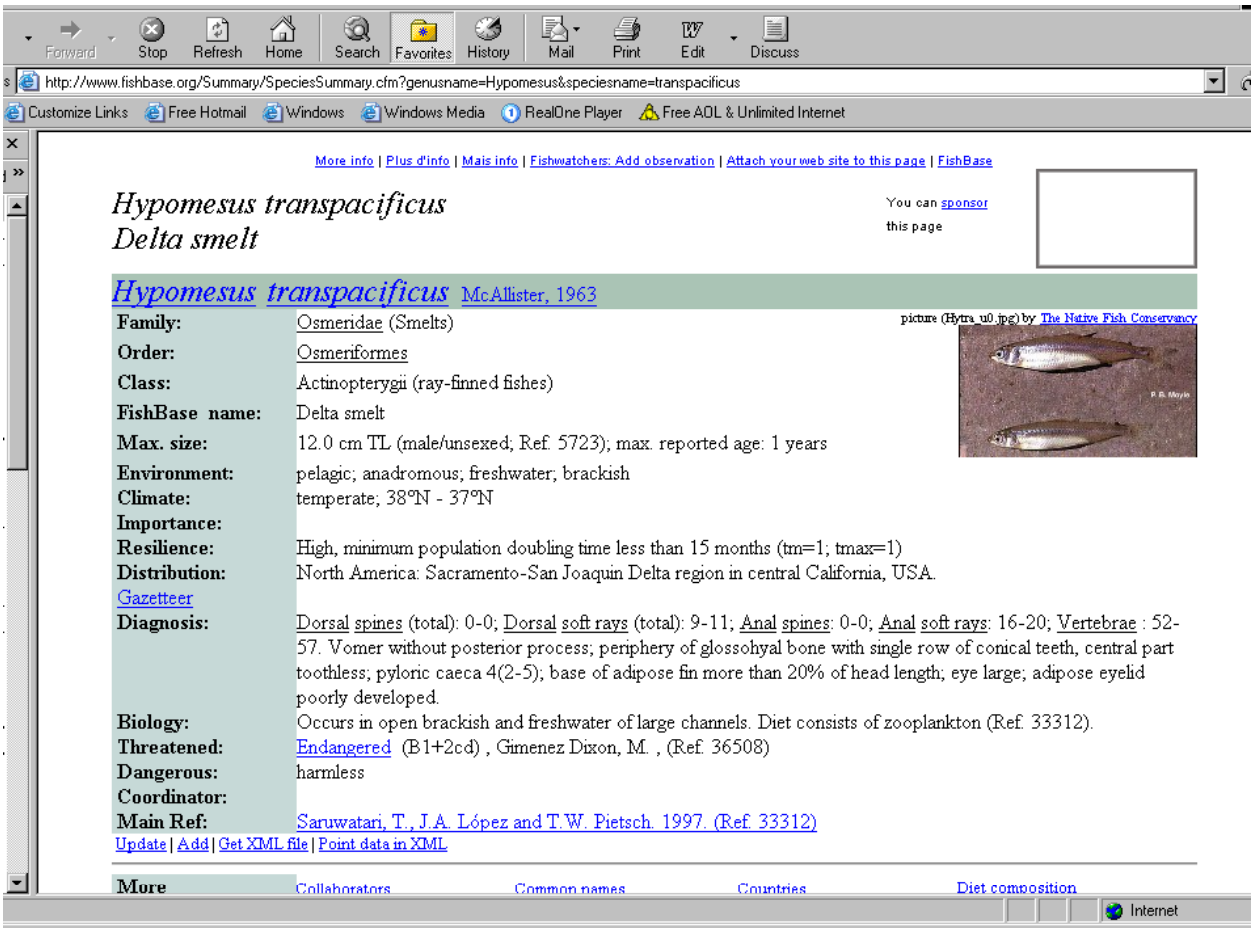
Attachment 2. Benthos Bio Guide Species List

EMP Organism Number	Organism Name
1010	Platyhelminthes Planariidae Dugesia tigrina
1230	Nematoda Dorylaimidae Dorylaimus Species A
1290	Nematoda Mermithidae Mermithid Species A
2210	Annelida Naididae Paranais frici
2410	Annelida Tubificidae Aulodrilus limnobius
2470	Annelida Tubificidae Bothrioneurum vejdovskyanum
2490	Annelida Tubificidae Branchiura sowerbyi
2510	Annelida Tubificidae Ilyodrilus frantzi capillatus
2530	Annelida Tubificidae Ilyodrilus templetoni
2550	Annelida Tubificidae Limnodrilus hoffermeisteri
2660	Annelida Tubificidae Teneridrilus calvus
2710	Annelida Tubificidae Tubificoides fraseri
2730	Annelida Tubificidae Varichaetadrilus angustipenis
3110	Annelida Spionidae Streblospio benedicti
3130	Annelida Spionidae Marenzelleria viridis
3170	Annelida Capitellidae Heteromastus filiformis
3370	Annelida Nereidae Neanthes succinea
3390	Annelida Goniadidae Glycinde armigera
3430	Annelida Sabellidae Manayunkia speciosa
4030	Arthropoda Cyprididae Isocypris Species A
4020	Arthropoda Cyprididae Herpetocypris brevicaudata
4150	Arthropoda Balanidae Balanus improvisus
4230	Arthropoda Leuconidae Nippoleucon hinumensis
4270	Arthropoda Tanaidae Sinelobus stanfordi
4310	Arthropoda Idoteidae Synidotea laevidorsalis
4510	Arthropoda Ampeliscidae Ampelisca abdita
4520	Arthropoda Ampeliscidae Ampelisca lobata
4530	Arthropoda Corophiidae Monocorophium acherusicum
4550	Arthropoda Corophiidae Corophium alienense
4560	Arthropoda Corophiidae Corophium heteroceratum
4610	Arthropoda Corophiidae Americorophium spinicorne
4630	Arthropoda Corophiidae Americorophium stimpsoni
4670	Arthropoda Aoridae Grandidierella japonica
4750	Arthropoda Gammaridae Gammarus daiberi
4810	Arthropoda Talitridae Hyalella azteca
5410	Arthropoda Chironomidae Procladius Species A
6500	Mollusca Philinidae Philine auriformis
6730	Mollusca Corbiculidae Corbicula fluminea
6770	Mollusca Sphaeriidae Pisidium compressum
6870	Mollusca Myidae Mya arenaria
6890	Mollusca Corbulidae Potamocorbula amurensis

Attachment 3. Flow-chart of proposed web links (underlined) for the Bio Guide to the IEP Home and EMP Web sites.



Attachment 4: Example Page from FishBase.



Forward Stop Refresh Home Search Favorites History Mail Print Edit Discuss

http://www.fishbase.org/Summary/SpeciesSummary.cfm?genusname=Hypomesus&speciesname=transpacificus

Customize Links Free Hotmail Windows Windows Media RealOne Player Free AOL & Unlimited Internet

More info | Plus d'info | Mais info | Fishwatchers: Add observation | Attach your web site to this page | FishBase

Hypomesus transpacificus
Delta smelt

You can sponsor this page

Hypomesus transpacificus McAllister, 1963

picture (Hytra_u0.jpg) by: The Native Fish Conservancy

Family:	Osmeridae (Smelts)
Order:	Osmeriformes
Class:	Actinopterygii (ray-finned fishes)
FishBase name:	Delta smelt
Max. size:	12.0 cm TL (male/unsexed; Ref. 5723); max. reported age: 1 years
Environment:	pelagic; anadromous; freshwater; brackish
Climate:	temperate; 38°N - 37°N
Importance:	
Resilience:	High, minimum population doubling time less than 15 months (tm=1; tmax=1)
Distribution:	North America: Sacramento-San Joaquin Delta region in central California, USA. Gazetteer
Diagnosis:	Dorsal spines (total): 0-0; Dorsal soft rays (total): 9-11; Anal spines: 0-0; Anal soft rays: 16-20; Vertebrae : 52-57. Vomer without posterior process; periphery of glossohyal bone with single row of conical teeth, central part toothless; pyloric caeca 4(2-5); base of adipose fin more than 20% of head length; eye large; adipose eyelid poorly developed.
Biology:	Occurs in open brackish and freshwater of large channels. Diet consists of zooplankton (Ref. 33312).
Threatened:	Endangered (B1+2cd) , Gimenez Dixon, M. , (Ref. 36508)
Dangerous:	harmless
Coordinator:	
Main Ref:	Saruwatari, T., J.A. López and T.W. Pietsch. 1997. (Ref. 33312)

Update | Add | Get XML file | Point data in XML

More Collaborators Common names Countries Diet composition

Internet

Attachment 5: Example Page from Oregon Estuarine Invertebrates

Corophium spinicorne
Stimpson, 1857

PHYLUM: *Arthropoda*
CLASS: *Crustacea*
ORDER: *Amphipoda, Gammaride*
FAMILY: *Corophiidae*

Description

SIZE—largest species of *Corophium* on the west coast: to 8 mm[6]; females, 10 mm, South Slough of Coos Bay, males, 6 mm, females, (largest) 8.5 mm.

COLOR—clear, with dark brown markings on antennae and thoracic segments.

FIRST ANTENNA—reaching to middle of fifth segment of second antenna; flagellum of 14-16 joints (male) or 11 (female). Female may have one to three spines on first and second joints of peduncle, (fig. 5).

SECOND ANTENNA—in males as long as or longer than body; fourth joint with large distal half moon tooth; no small accessory tooth; fifth joint with distal spine, and proximal spine which is well within tooth when joint is flexed (fig. 1). Females have similar toothed fourth joint (fig. 5), with spines also on the fifth joint; the fifth joint proximal spine, however, opposes the large half moon tooth when the joint is flexed. Both sexes have prominent gland cones on the second article (figs. 1, 5), but that of the female is acute and curves forward sharply (fig. 5).

ROSTRUM—both sexes: rounded (fig. 3b, 4)[6]; but males sometimes straight (fig. 3a).

SECOND GNATHOPOD, UROSOME, THIRD UROPOD—"typical" *Corophium* types: (see *C. brevis*, (figs. 3,4).

SETOSE LAMELLAE—pairs of broodplates attached to bases of coxae (fig. 6) on females only. (Do not confuse with fleshy gills, present on both sexes.)

Possible Misidentifications

None of the other *Corophium* in this "cluster" have the large tooth on the second *antenna* without the small accessory tooth inside it. First, it is important to determine that the segments of the urosome are separate, not fused. Males and females of *C. spinicorne* can be separated by the second antennal features (see above), and by lamellae and/or eggs in the females.

Ecological Information

RANGE—estuaries and brackish waters from Santa Cruz, California, to Alaska; also in freshwater.

DISTRIBUTION—Oregon estuaries and lakes; South Slough of Coos Bay, Tillamook Bay; Floras Lake.

HABITAT—Substrate—mud; beach and log boom[1]; areas of heavy silting[5]; prefers sand[2].

SALINITY—brackish to freshwater; 0.02-33.6 o/oo[2].

TIDAL LEVEL—

TEMPERATURE—10.-22.8°C.[2]

ASSOCIATES—

Quantitative Information

WEIGHT—

ABUNDANCE—in excess of 100/m_2[2].

Life History Information

REPRODUCTION—

GROWTH RATE—

LONGEVITY—

FOOD—

PREDATORS—young chinook[3].

BEHAVIOR—

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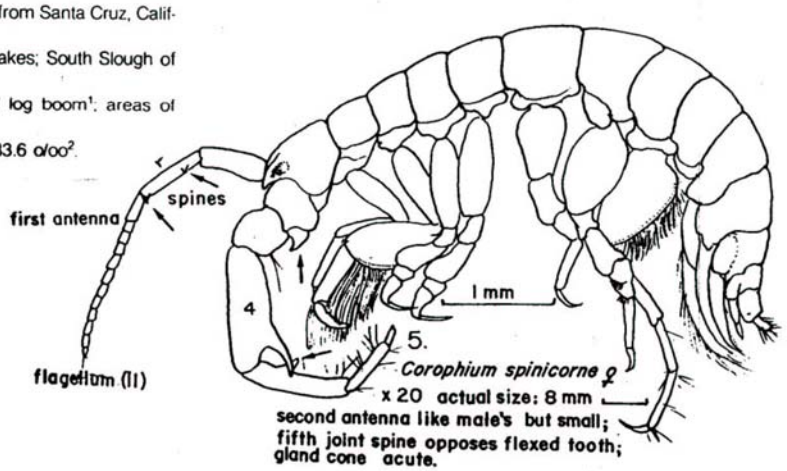
1. Barnard, J. L., 1954. Marine amphipoda of Oregon, 103 pp. Ore. State Coll. Corvallis, p. 36.
2. Eriksen, C. H., 1968. Aspects of the limno-ecology of *Corophium spinicorne* Stimpson (Amphipoda) and *Gnorimosphoeroma oregonensis* (Dana) (Isopoda) Crustaceana 14:1-12.
3. Forsberg, Brent O., *et al.* 1977. Tillamook Bay Study, 117 pp. Ore. Dept. Fish & Wildlife.
4. Kozloff, 1974a. Key, to genus only, p. 155-156.
5. Kozloff, 1974b. Brief natural history of genus, pp. 83-4.
6. Shoemaker, C. R., 1949. The amphipod genus *Corophium* on the west coast of America. J. Wash. Acad. Sci., 45:1-59. Description, plate, pp. 74-76.



Attachment 6: Prototype for the Benthos Bio Guide Introduction Page (web links underlined)

Benthos Bio Guide : A Guide to the Common and Important Benthic Invertebrates of the San Francisco Estuary.

Home | Links | IEP Web site | IEP Benthos Database | EMP Info | Bio Guide Team

Corbicula fluminea C. Messer

Introduction

The Benthos Bio Guide is funded by the California Interagency Ecological Program for the purpose of providing a single, comprehensive source for basic biological, ecological and identification information for common and important benthic invertebrates of the upper San Francisco Estuary. Species comprising the Benthos Bio Guide were selected based on data from the IEP Environmental Monitoring Program. Information for individual species in the Benthos Bio Guide is compiled in a Species Summary Page which includes information on classification, identification, species status in the SFE, environmental requirements, reproduction, trophic ecology, occurrence in the upper SFE, behavior, and main references used. Additional information and links are provided on Secondary Pages.

Species List (click here)

- Lists all species included in the Benthos Bio Guide and provides direct links to Species Summary Pages.

Glossary (click here)

- Lists taxonomic terms used for identification of species.

Last Modified by CM, 25.09.02. (dd,mm,yy)

Attachment 7: Prototype for a Benthos Bio Guide Species Summary Page (web links underlined)

Potamocorbula amurensis Schrenck, 1861
Asian clam, Chinese clam, Overbite clam

Reference Collection Code: 6890
(IEP Relational Data Base)

Taxonomic Information

Phylum: Mollusca
Class: Bivalvia
Subclass: Heterodanta
Order: Myoida
Superfamily: Myoidea
Family: Corbulidae
Genus: Potamocorbula
Species: amurensis

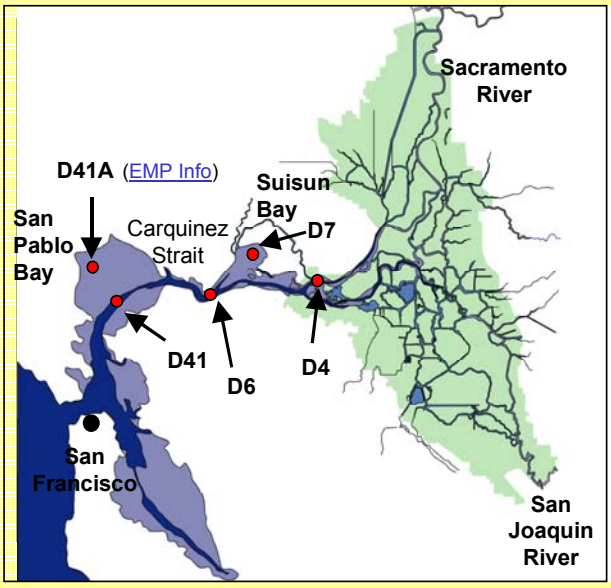
Species Status in SFE

Introduced around 1986.
Native to China, Japan and Korea.
Non-threatening to humans, has caused significant reduction in phytoplankton density in SFE since introduction.

Identification

Small clam (maximum size = 27.5 mm). Shell thin and ovate, white, tan or yellow in color. Inequivalve shell (valves not equal in size) left valve smaller. flat and drawn into the larger more swollen right valve. Prominent external keel and umbonal keel on the posterior end of the left valve extending to the ventro posterior margin. Fine striae on older specimens. Brown siphons, one short, incurrent siphon bears pinnate tentacles, non-pinnate excurrent tentacles bear two long, medial filament. Entire mantle fringed with papillae. Very shallow pallial sinus.

Occurrence in the upper SFE (from EMP data)



Environmental Requirements in SFE

Habitat: predominantly subtidal, some intertidal mudflats.
Substrate: all sediment types, most abundant in mud-sand bottoms.
Salinity: Freshwater (< 1ppt) to saline (32.6 ppt)
Temperature: 8^0 C to 23^0 C

Reproduction

Individuals dioecious. Gametogenesis usually occurs in fall, fertilized eggs released into water (16 - 20^0 C), settlement occurs after 30 to 40 days. May have several reproductive events depending on environmental conditions.

Life Stages

egg → trochophore larvae → veliger → spat → adult

Behavior

Infaunal burrowers, leaving one-third to one-half of shell exposed for feeding purposes. Move vertically to utilized sediment-water interface.

Trophic Ecology

Filter feeds on diatoms and nauplii of copepods. Predators include diving birds (scaups, scoters) dungeness crabs and white sturgeon.

Main Reference

Carlton, J.T., J.K. Thompson, L.E. Schemel and F.H. Nichols Remarkable invasion of San Francisco Bay (California, USA) by the Asian clam *Potamocorbula amurensis*. I. Introduction and dispersal. 1990. Marine Ecology Progress Series. 66:81-94.

More Information in Secondary Pages

References| Internet Links| Global Distribution| Pictures